Monitoring and Tracking Nitrogen Deposition at Rocky Mountain National Park: 2013 Report

Kristi Morris[1], Alisa Mast[2], Greg Wetherbee[3], Dave Clow[2], David Gay[4], Jill Baron[5], Curt Taipale[6], and Tamara Blett[1]

[1]National Park Service, Air Resources Division
[2]US Geological Survey, Rocky Mountain Region, Water Resources Division
[3]US Geological Survey, Branch of Quality Systems, NADP External QA Project
[4]NADP Program Office, Program Coordinator
[5]US Geological Survey, Natural Resource Ecology Laboratory, CSU
[6]Colorado Department of Public Health and Environment, Air Pollution Control Division

Wet deposition is monitored by the National Atmospheric Deposition Program (NADP)

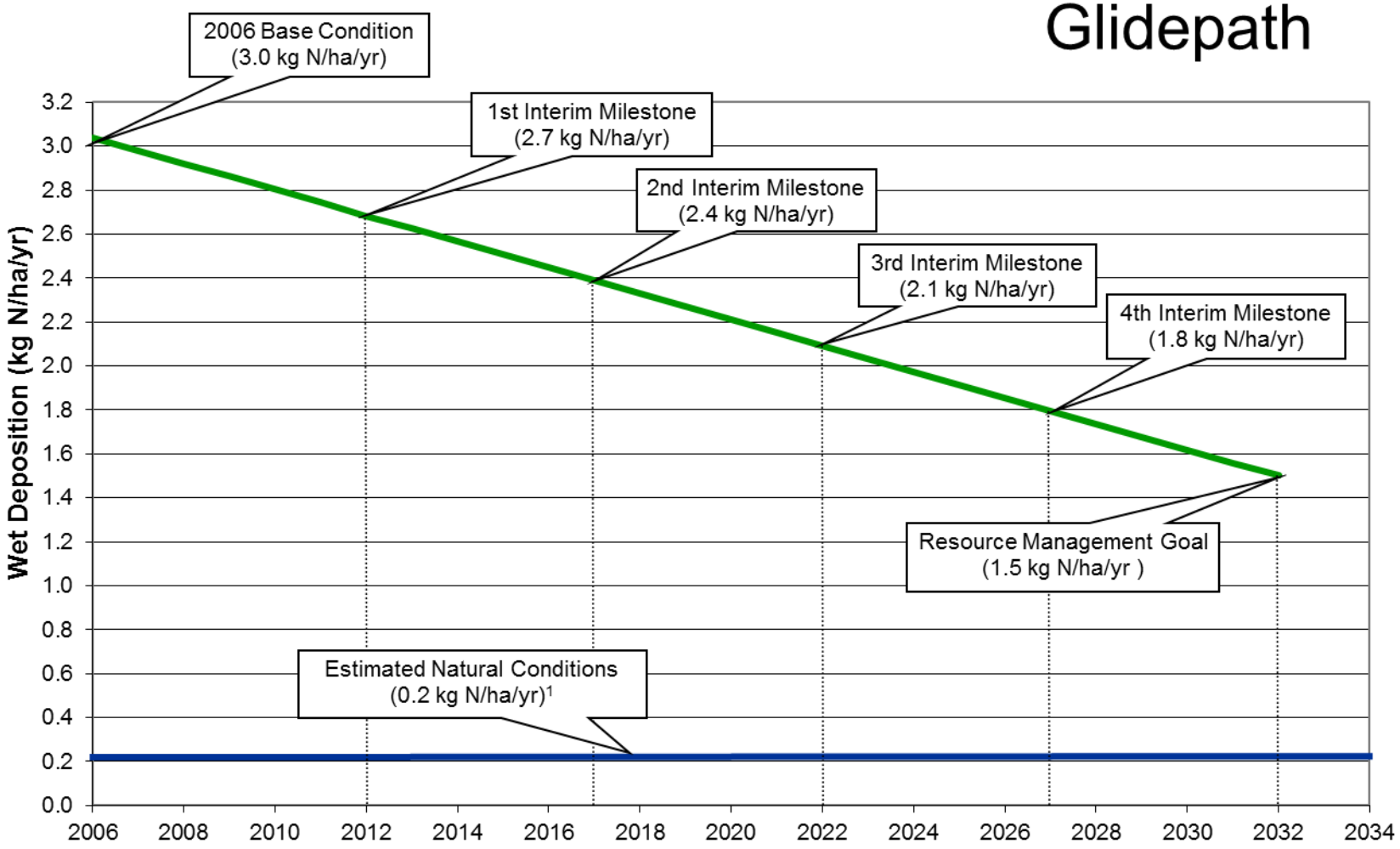
- NADP has been collecting deposition data for 34 years.
- Currently the network comprises ~250 sites across the US.
- Funded cooperatively by USGS, EPA, NPS, USDA, State Ag Experiment Stations, universities, governmental, and private entities.
- In 2013, NADP data were cited in ~180 peer-reviewed journal articles.
- NADP data used by EPA to assess Acid Rain Program.

How is nitrogen deposition at RMNP tracked?

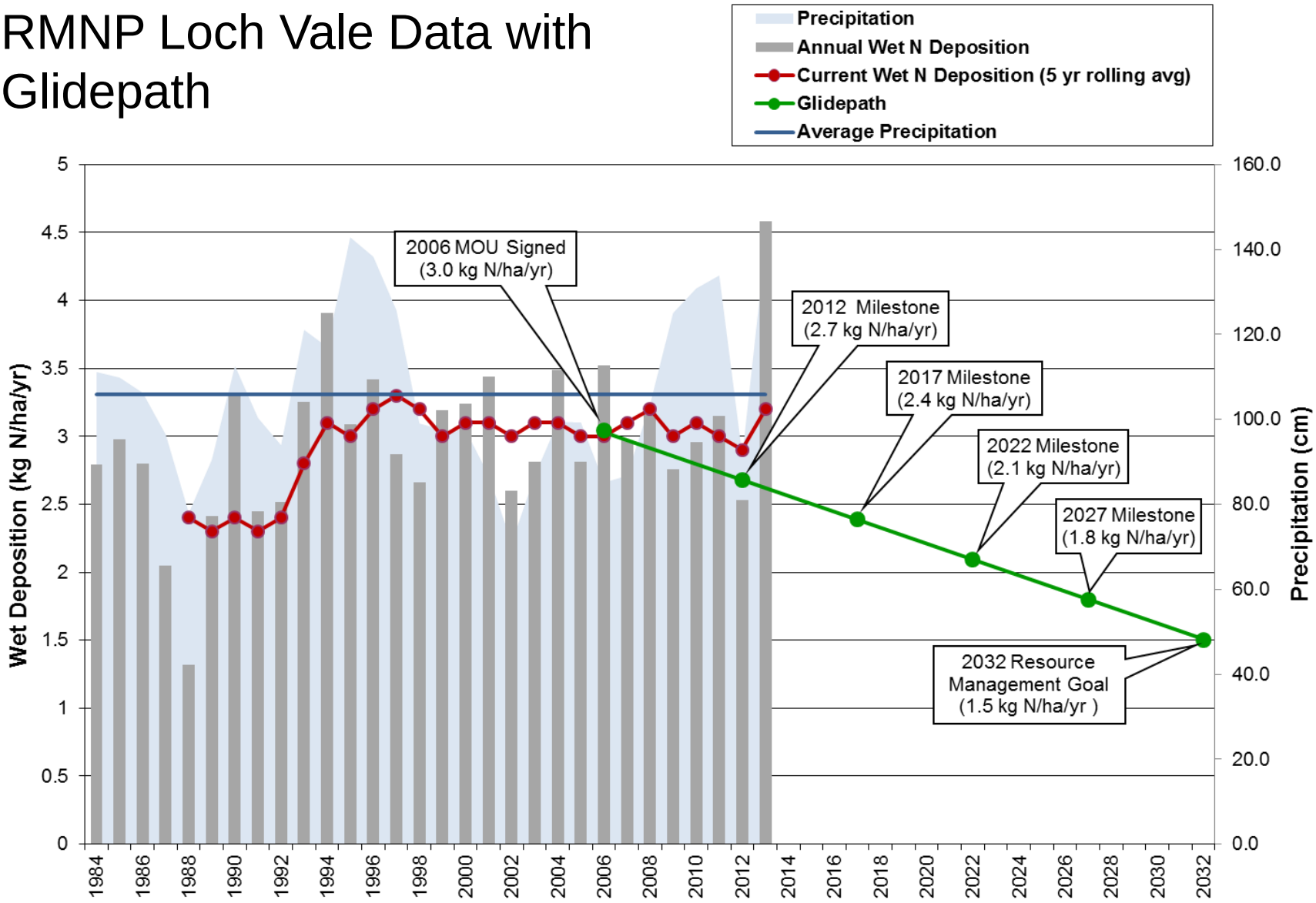
Several analyses will be used to track nitrogen deposition at RMNP. These analyses may be modified as better information becomes available and will include, but are not limited to:

- assessment of progress along the glidepath,
- long-term trend analyses for RMNP and other regional sites, and
- shorter-term trends analyses for RMNP and other regional sites.

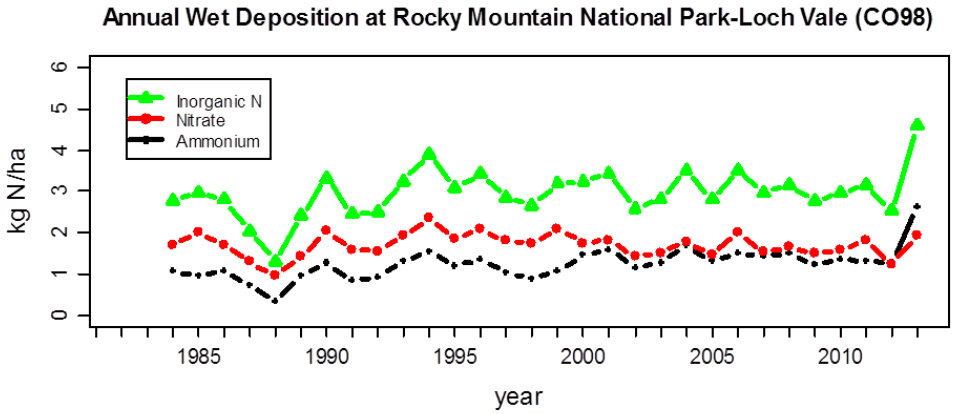
Glidepath


2006 Base Condition
(3.0 kg N/ha/yr)
1st Interim Milestone
(2.7 kg N/ha/yr)
2nd Interim Milestone
(2.4 kg N/ha/yr)
3rd Interim Milestone
(2.1 kg N/ha/yr)
4th Interim Milestone
(1.8 kg N/ha/yr)
Resource Management Goal
(1.5 kg N/ha/yr)
Estimated Natural Conditions
(0.2 kg N/ha/yr)[1]
Wet Deposition (kg N/ha/yr)
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034

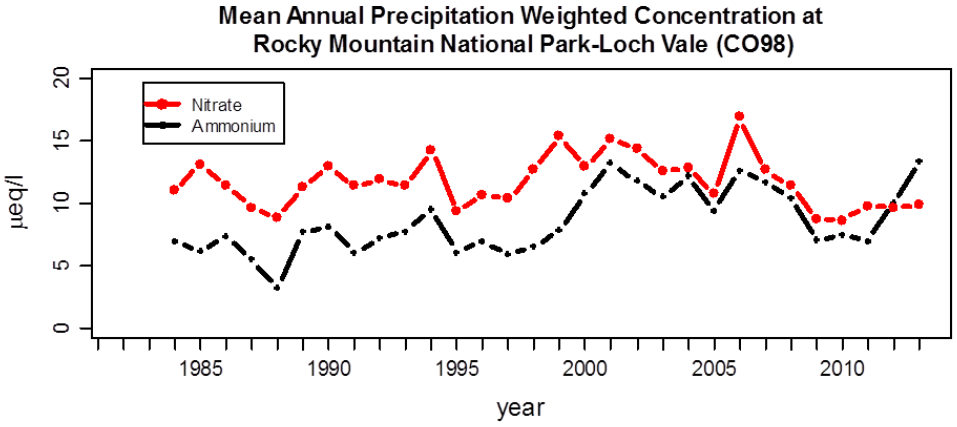
RMNP Loch Vale Data with Glidepath



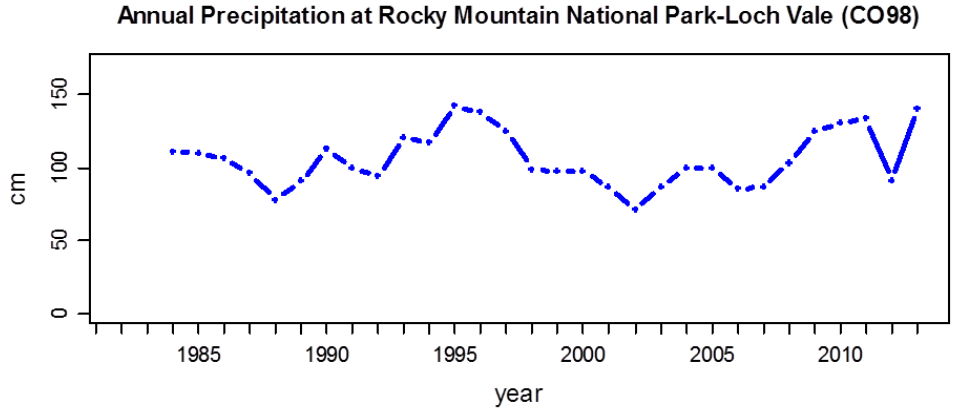
RMNP – Loch Vale



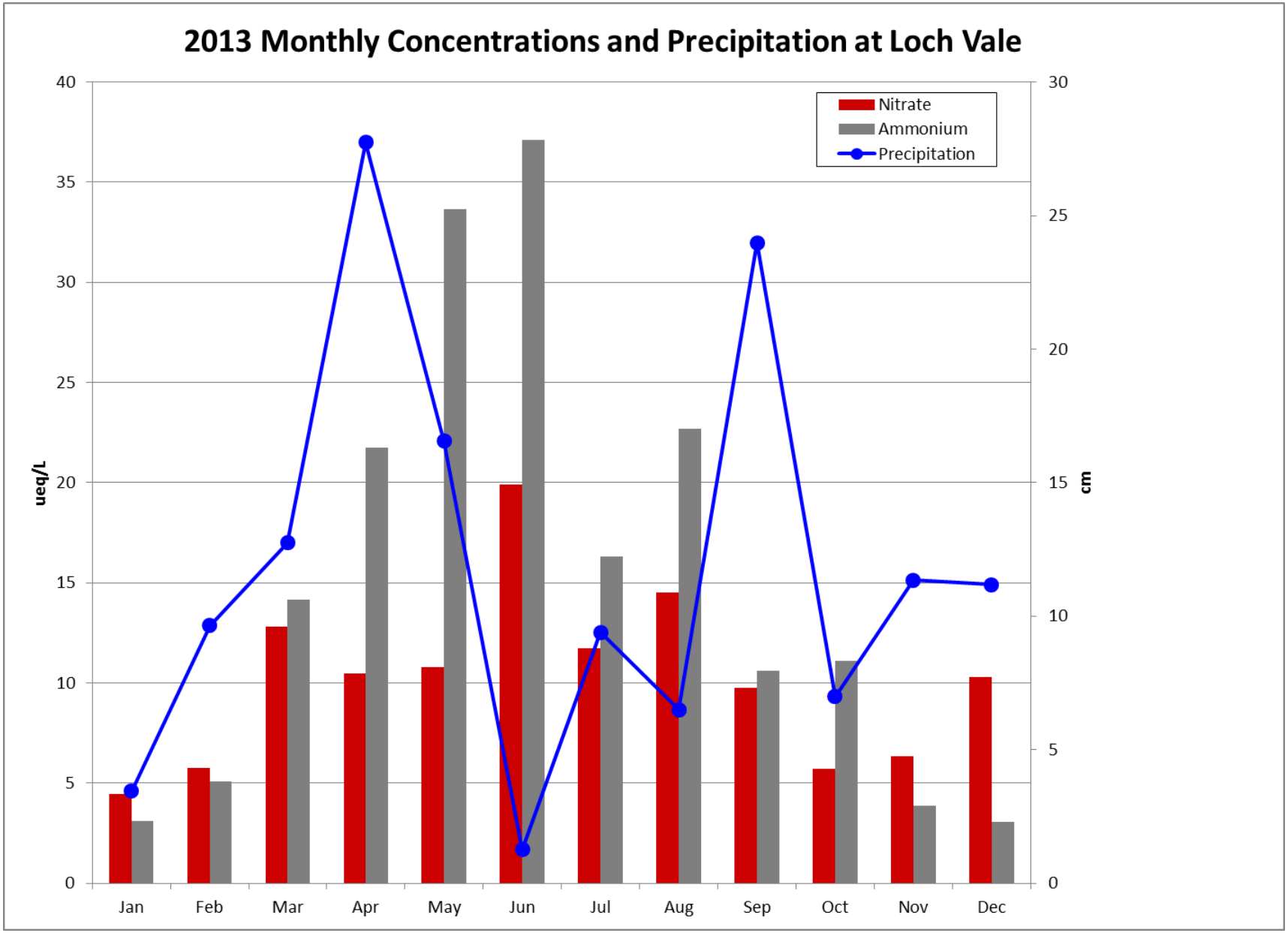
Deposition

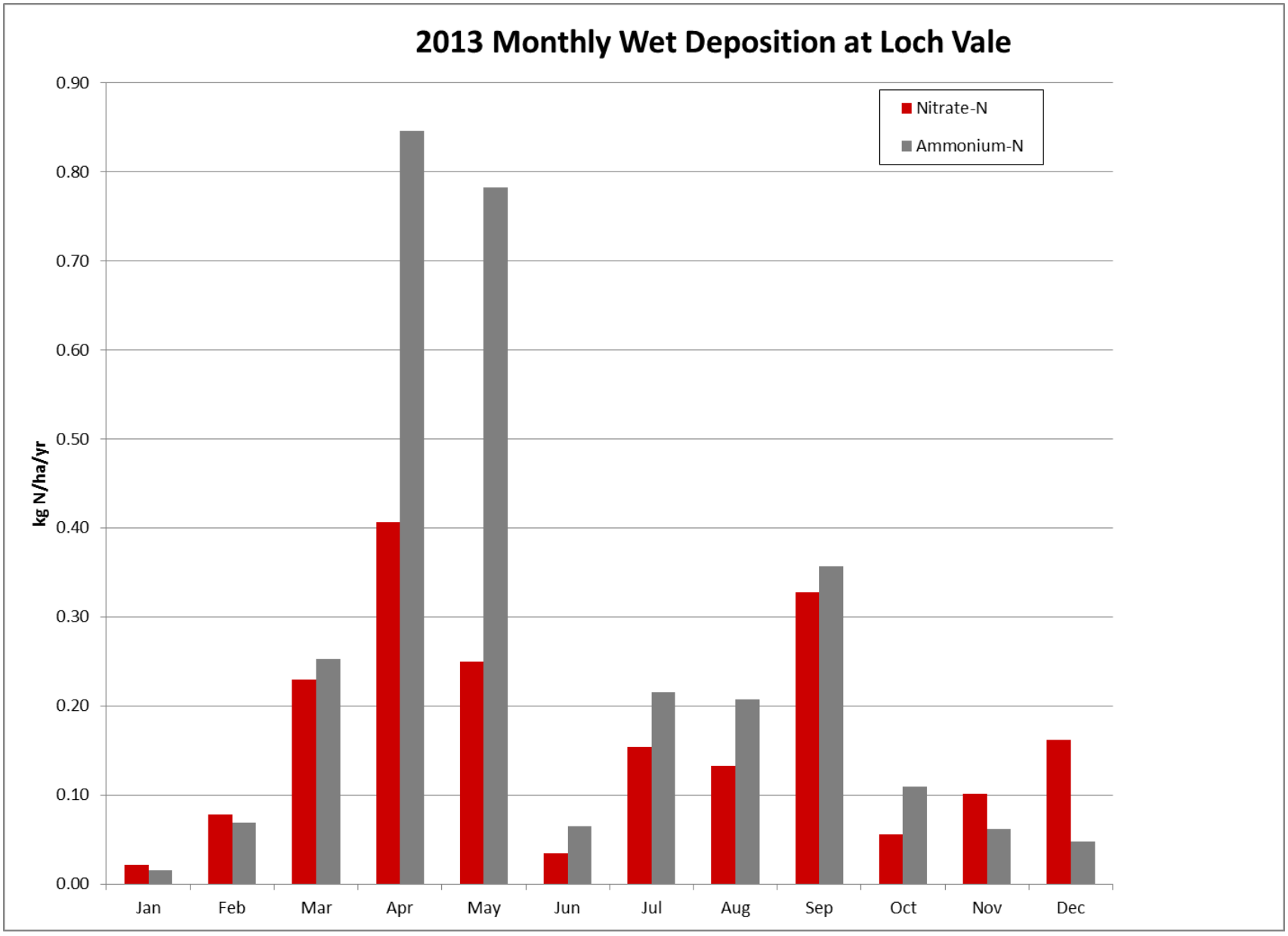


Concentration

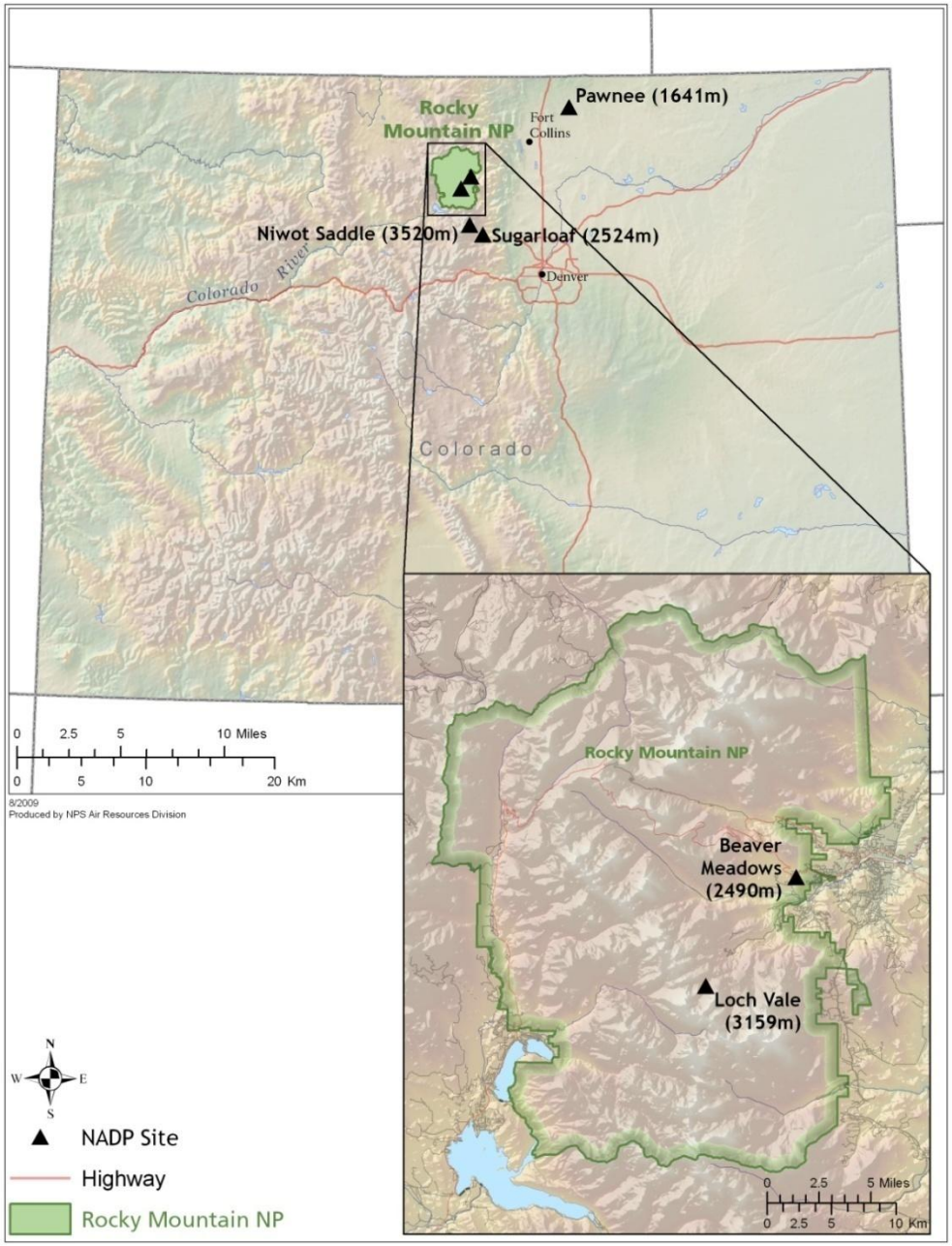


Precipitation


2013 Monthly Concentrations and Precipitation at Loch Vale
Nitrate
Ammonium
Precipitation
ueq/L
cm
0
5
10
15
20
25
30
35
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


2013 Monthly Wet Deposition at Loch Vale
kg N/ha/yr
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Nitrate-N
Ammonium-N
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

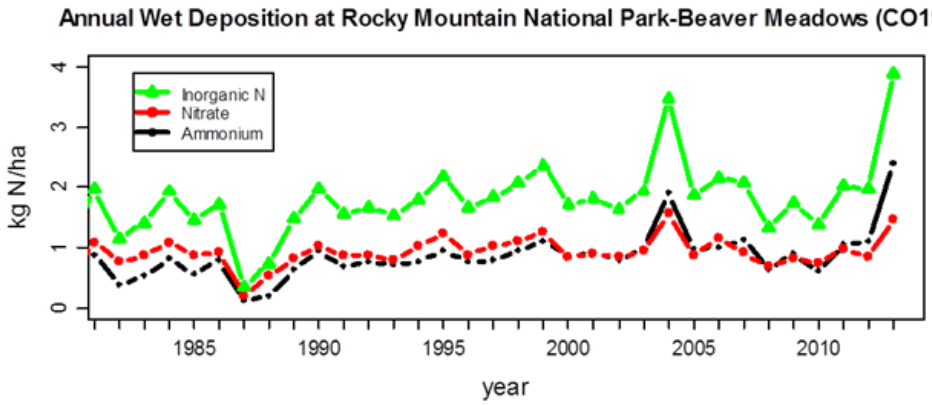
Location of RMNP and other regional sites included in trends analysis.



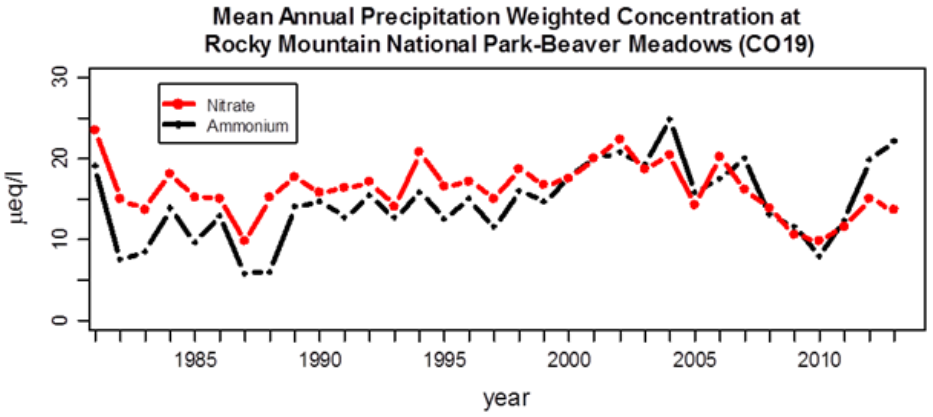
Site details of RMNP and other regional sites.

Site Name	Site ID	Start Date	Elevation (feet)
Rocky Mountain National Park-Loch Vale	CO98	8/16/1983	10,364
Rocky Mountain National Park-Beaver Meadows	CO19	5/29/1980	8,169
Niwot Saddle	CO02	6/5/1984	11,549
Sugarloaf	CO94	11/4/1986	8,281
Pawnee	CO22	5/22/1979	5,384

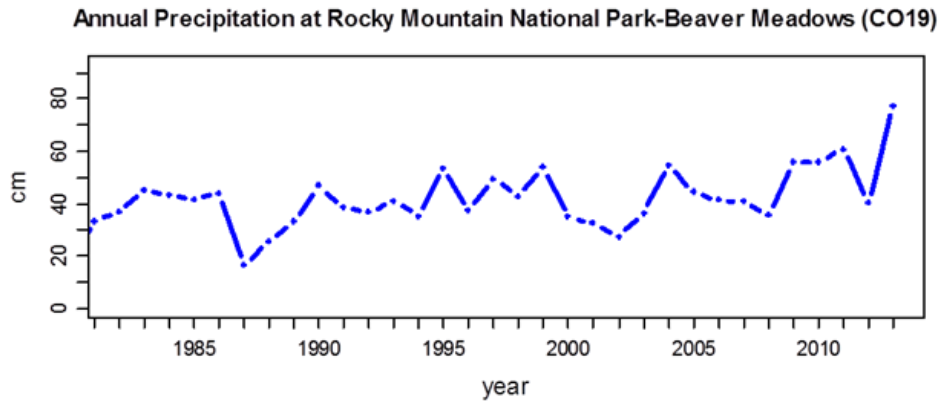
RMNP – Beaver Meadows



Deposition

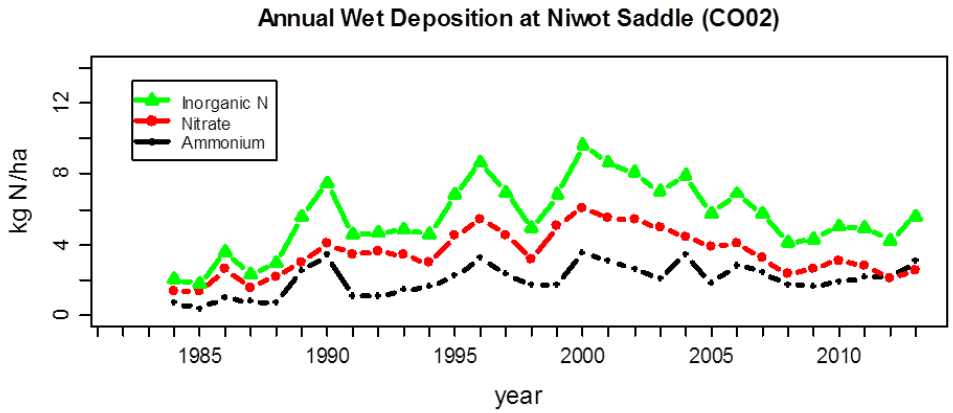


Concentration

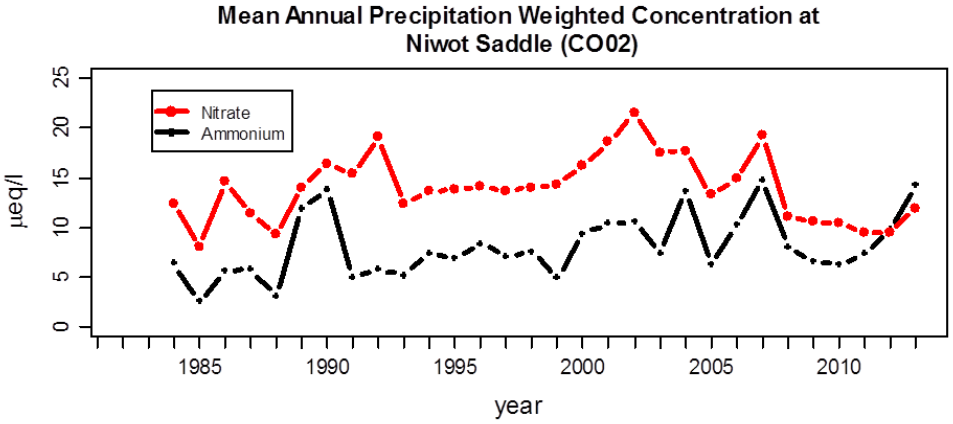


Precipitation

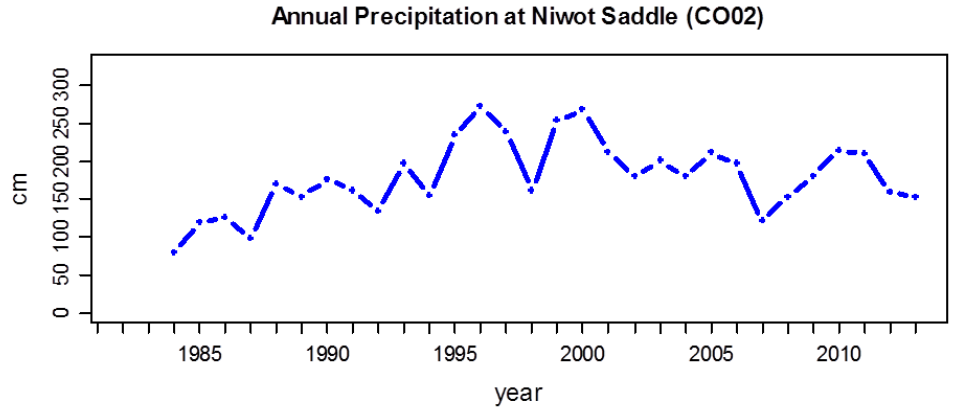
Niwot Saddle



Deposition

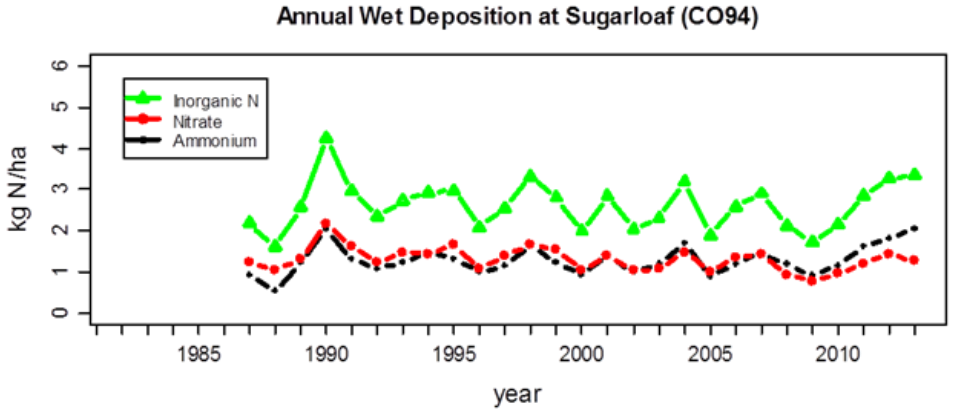


Concentration

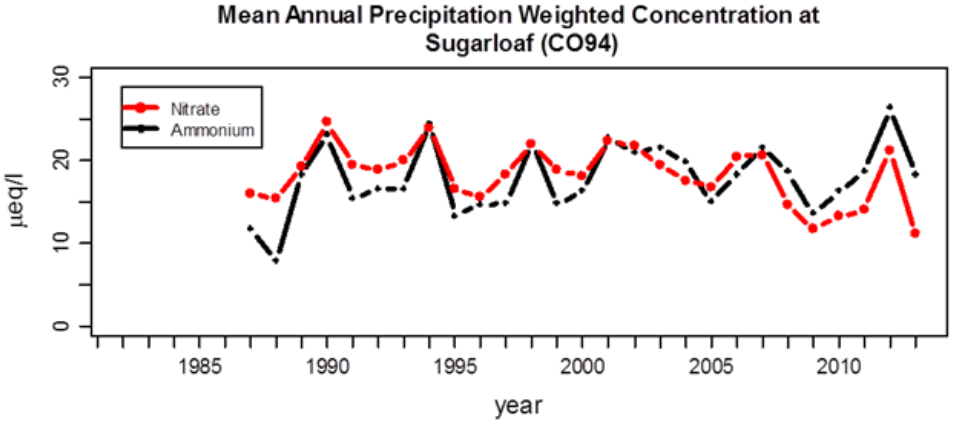


Precipitation

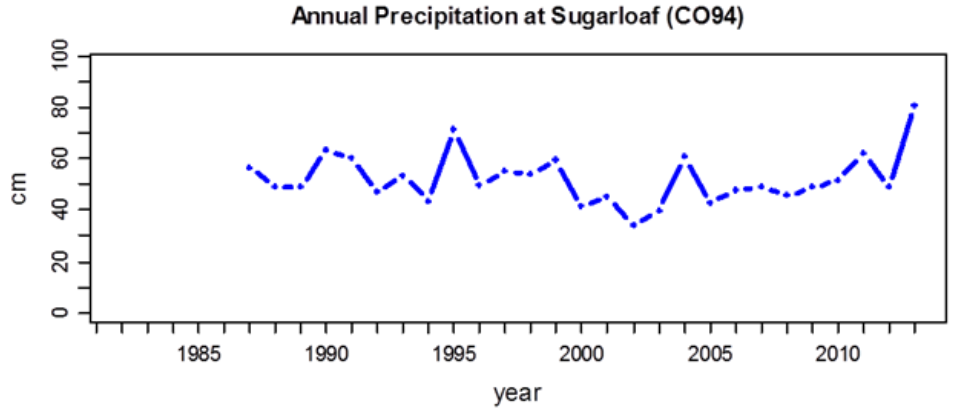
Sugarloaf



Deposition

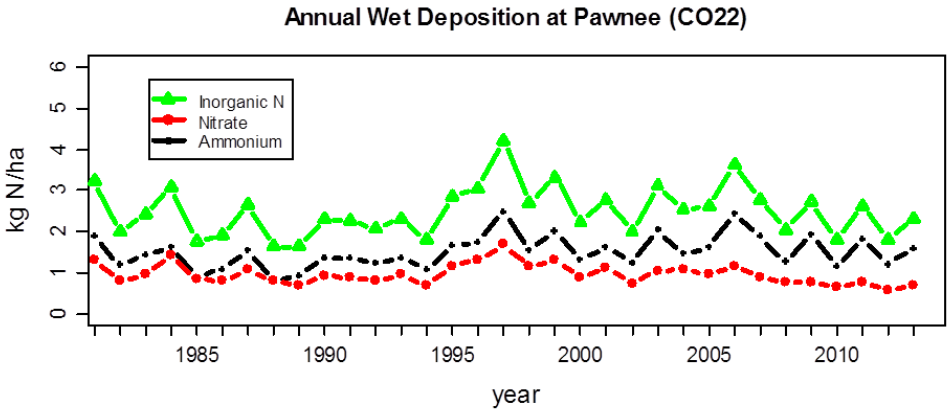


Concentration

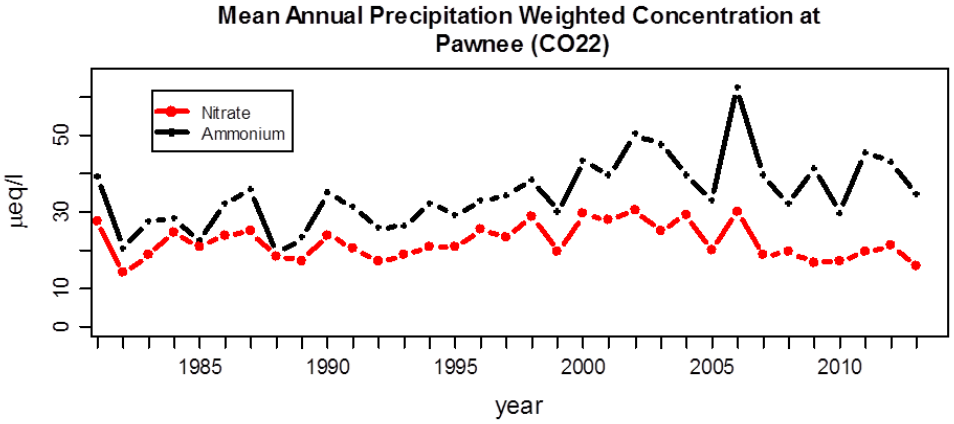


Precipitation

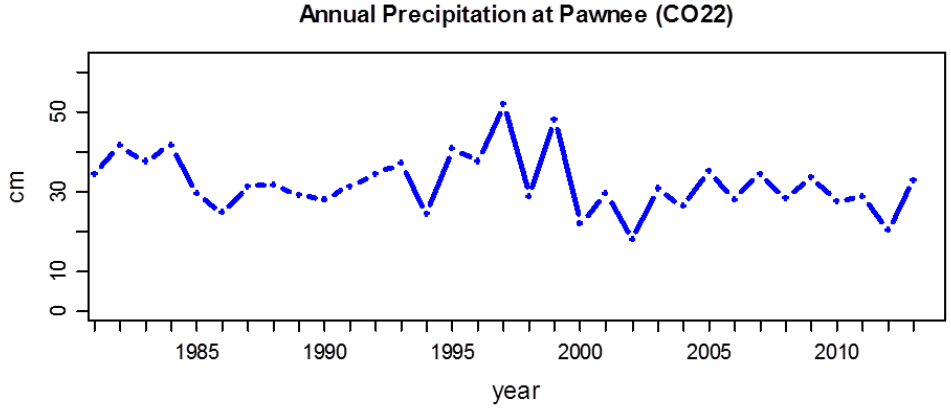
Pawnee



Deposition



Concentration



Precipitation

About Trends

- Seasonal Kendall Test (SKT) is a widely-used, trusted statistical test for environmental data.

- Variety of parameters :

    1) Deposition because it is relevant to the ecosystem and resource management goal.
    2) Concentration allows for comparison of sites with less influence of precipitation amount, more closely relates to air quality.
    3) Precipitation because it affects deposition.

deposition = concentration x precipitation

Significant Long-term Trends (27-34 years)

Wet Nitrogen Deposition:

Beaver Meadows	increasing

Ammonium Concentration:

Loch Vale	increasing
Beaver Meadows	increasing
Niwot Saddle	increasing
Pawnee	increasing

Nitrate Concentration:

Sugarloaf	decreasing

Precipitation:

Beaver Meadows	increasing

Significant Short-term Trends (5 or 7 years)

Wet Nitrogen Deposition:

Pawnee	decreasing (7yrs)

Ammonium Concentration:

Loch Vale	increasing (5yrs)
Beaver Meadows	increasing (5yrs)
Niwot Saddle	increasing (5yrs)
Pawnee	increasing (5yrs)

Nitrate Concentration:

none

Precipitation:

none

Summary

Assessment of progress along the glidepath.
Is current wet nitrogen deposition in RMNP on or below the glidepath?

- Wet nitrogen deposition was above the glidepath in 2013.

Long-term trend analyses for RMNP and other regional sites.
Has nitrogen deposition decreased at RMNP and other sites in the region in the long term?

- Nitrogen deposition has not decreased at RMNP or other sites in the region over the long term.
- However trends did go from increasing to stable starting in 2010.
- Significant increases were found in wet N deposition at Beaver Meadows and in ammonium concentrations at 4 of the 5 regional sites.

Short-term trends analyses for RMNP and other regional sites.
Has nitrogen deposition recently decreased at RMNP and at other sites in the region?

- There is no trend in nitrogen deposition at RMNP over the short-term.
- Previously stable trends in ammonium are now increasing at four sites.
- Previously decreasing trends in nitrate are now stable at three sites.

Monitoring Site at Loch Vale

- Original site has operated since 1983
- Co-located site operated for five years (2009-2014)
- Wetherbee preparing NADP QA report
- Rain gage left in place to complete record

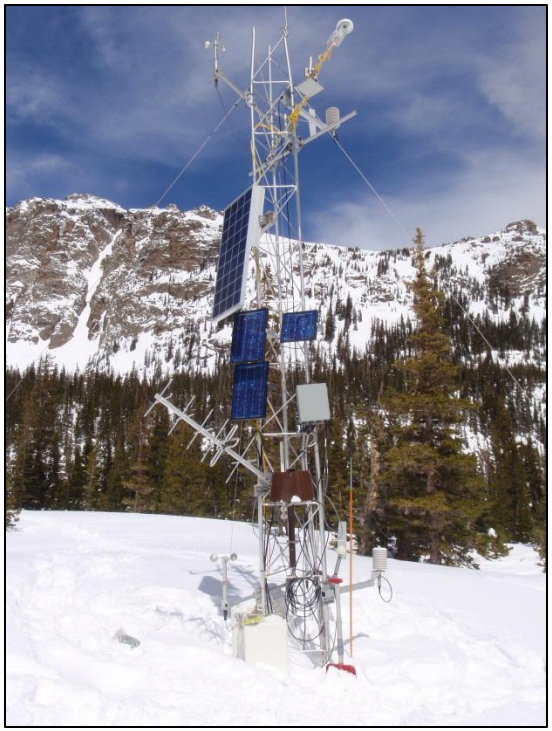
Acknowledgements

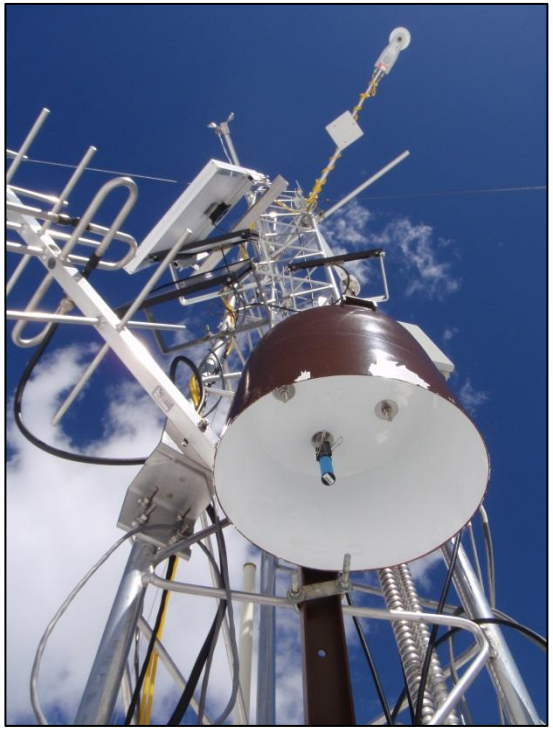
Chris Lehmann (NADP-CAL), Mark Rhodes (NADP), Jim Cheatham (RMNP), Lisa Clarke (CDPHE), Eric Richter (NEON), Jared Heath (CSU).

Final Report April 2015

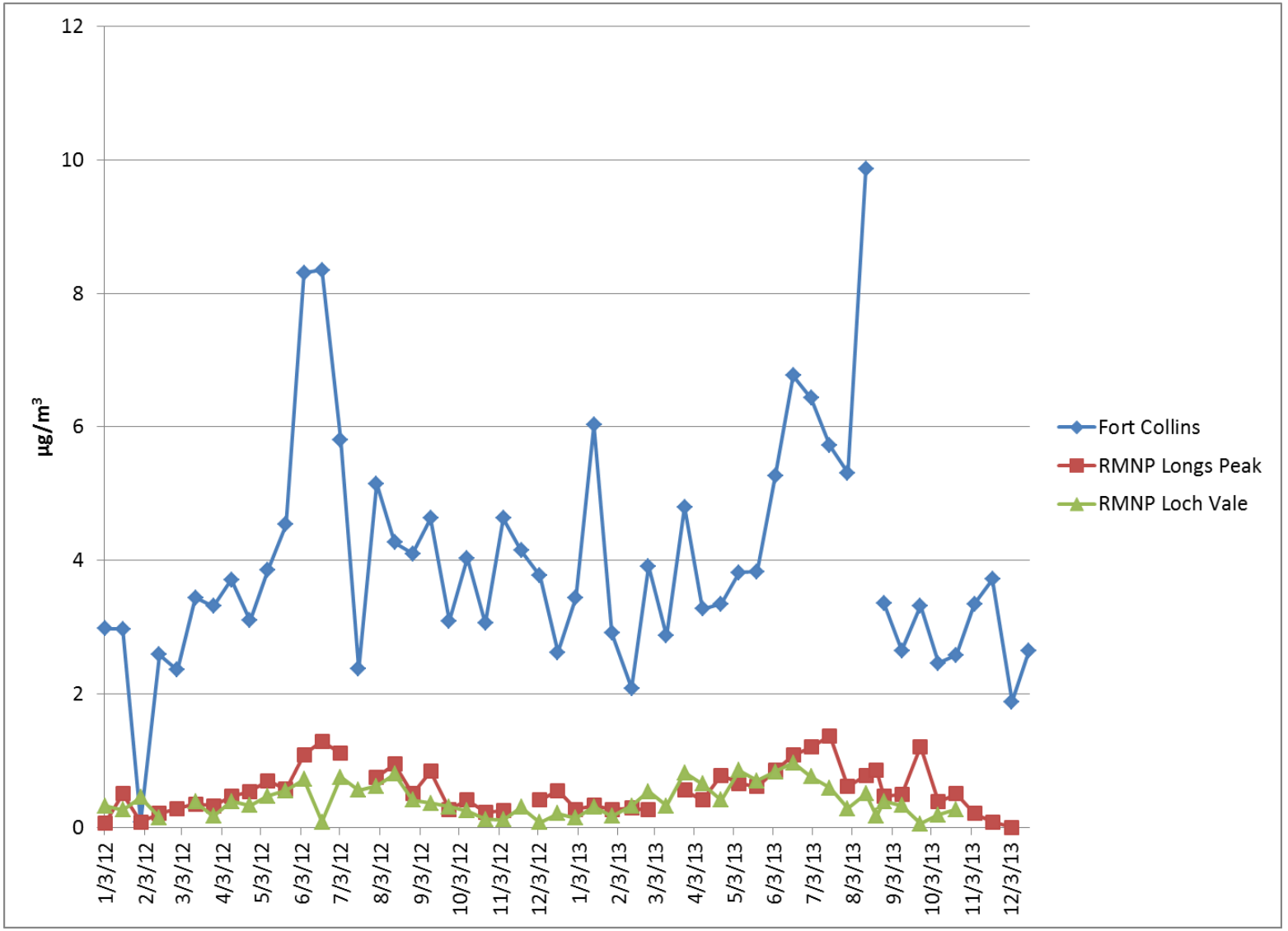
Passive Ammonia (NH3) Monitoring Sites

- NADP/Ammonia Monitoring Network (AMoN) measures NH_3 gas at Loch Vale, Longs Peak Ranger Station, and Fort Collins
- Installed in summer 2011

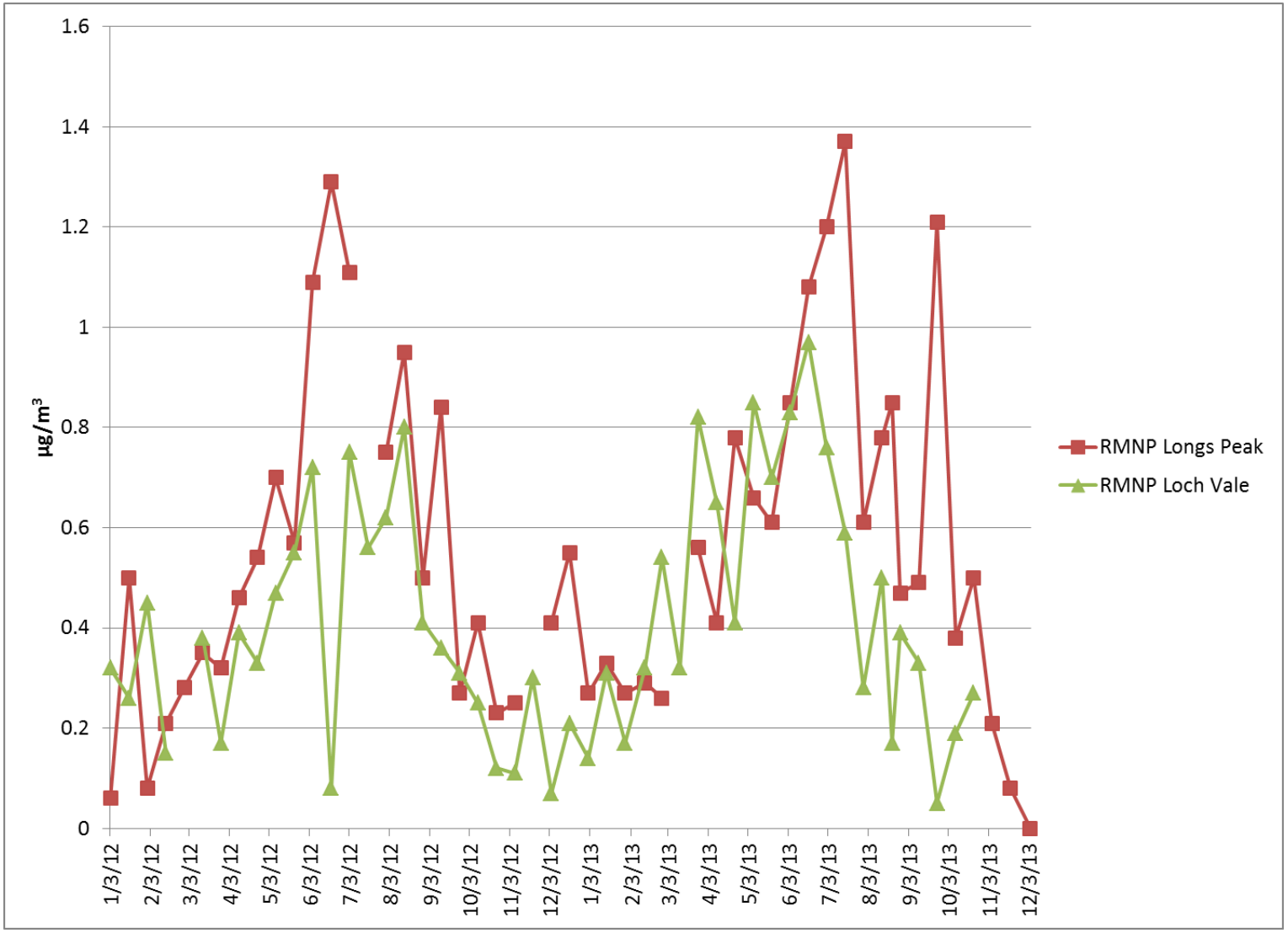




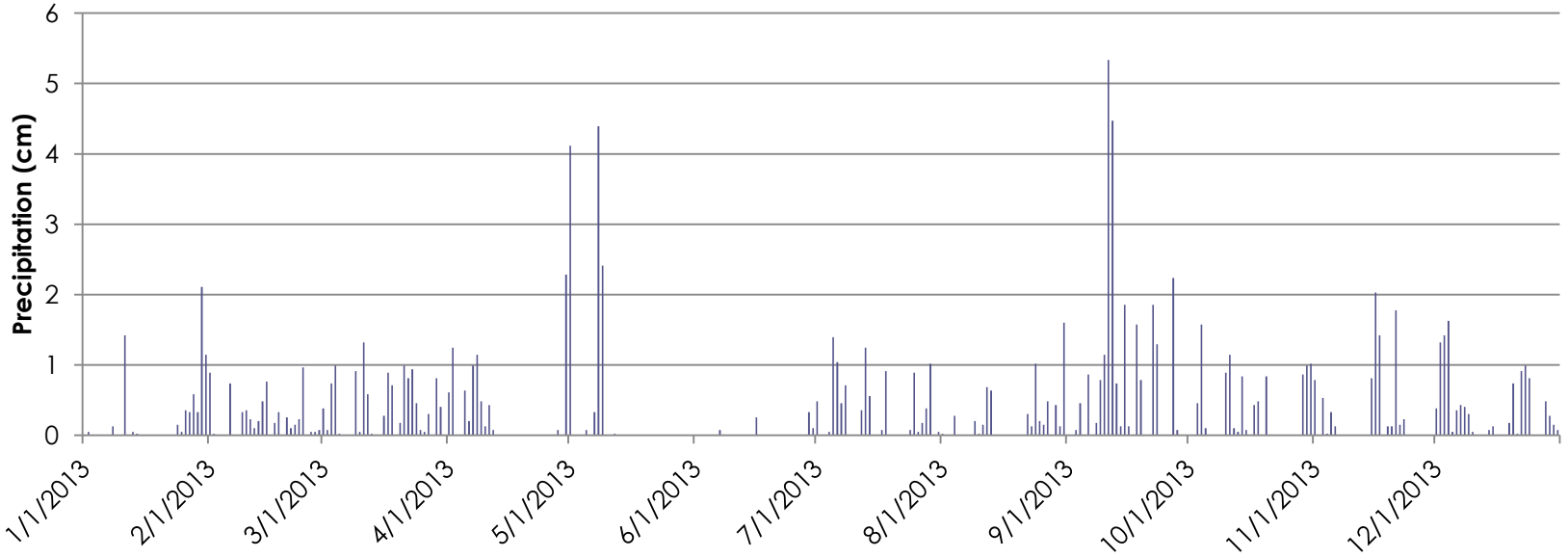
Ammonia Gas Concentrations



Ammonia Gas Concentrations



2013 Precipitation CO98



2013 Precipitation CO89